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Breeding Bird Survey Transect of Chicago Metropolitan Area, Illinois

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**ABSTRACT:** Fifty-one bird species were observed on five Breeding Bird Survey transects in the Chicago metropolitan area during June, 1976-1978. House Sparrows, Starlings, Common Grackles, American Robins, and Rock Doves comprised over 85% of all birds seen. The number of species observed was greatest in forested suburbs and least in inner-city neighborhoods. The extent of tree canopy and the size of grassy yards were significantly correlated with numbers of species. The habitat of particular residential neighborhoods determined which species were found and their relative abundances. The species observed were categorized into 8 groups based on patterns of bird abundance and distribution.

## **PURPOSE OF THE STUDY**

The Breeding Bird Survey (abbreviated BBS) technique was used to census birds across several transects of the Chicago metropolitan area during June, 1976-1978. The BBS provides a standardized sampling technique to compare neighborhood to neighborhood and provides annual indices to breeding bird density (Robbins and Van Velzen 1967, 1969). My purposes in this paper are to determine: (1) to what extent breeding bird populations differ between various neighborhoods of the metropolitan area, (2) whether differences in these neighborhood bird populations are related to habitat changes, and (3) whether urban birds can be classified into patterns of density and distribution. This study also serves as a basis for comparisons against future bird populations in Chicago.

## **METHODS AND STUDY AREAS**

BBS surveys were begun at  $1/2$  hr before sunrise. A standard route included stops spaced at 0.8 km intervals. I spent 3 min at a stop and recorded all birds heard, and all seen within 0.4 km. Robbins and Van Velzen (1967) have described the BBS technique

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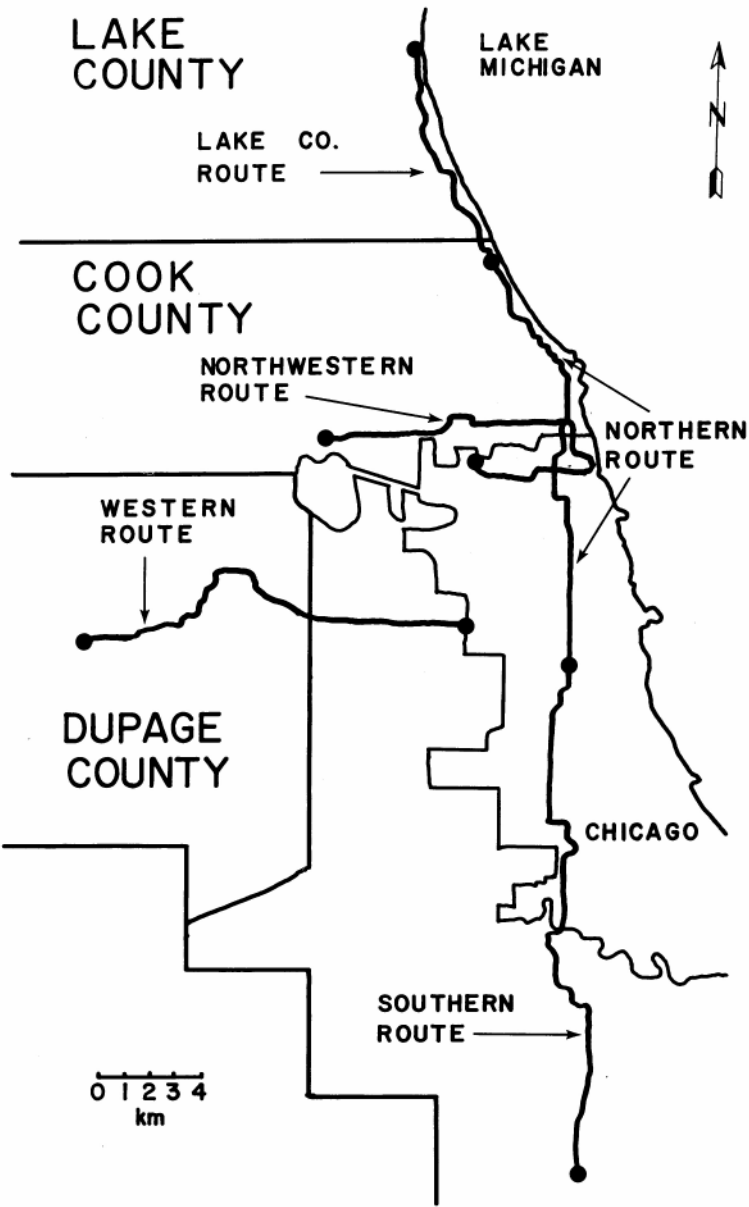


Figure 1. Chicago metropolitan area, Illinois, showing locations of Breeding Bird Survey transects.

in detail. I used 5 routes in this study (Figure 1). (1) The Lake County route (25 stops) followed Sheridan Road from Lake Bluff to Glencoe and was conducted on June 14, 1976, June 20, 1977, and June 20, 1978. (2) The northern route (45 stops) followed Sheridan Road and residential streets paralleling Western Avenue from Glencoe to Chicago's 14th Street. This route was conducted on June 13, 1976, June 19, 1977, and June 18, 1978. (3) The southern route (50 stops) extended from 14th Street in Chicago to Chicago Heights, paralleling Western Avenue on June 20, 1976. (4) The western route (50 stops) proceeded from Oak Park to Wheaton on June 22, 1976. (5) The northwestern route (50 stops) was U. S. Fish and Wildlife Service route 34-006, and was conducted on June 21, 1976, June 21, 1977, and June 19, 1978. The northern and southern routes were run on Sundays to minimize the effects of noise and human disturbance. Exact stopping locations are available upon request.

On a separate visit to each stop, I estimated 5 habitat parameters for the neighborhood within a 0.2 km radius of the stop. These were percentage of tree canopy, percent of lots used for residential purposes, percent of lots occupied by buildings to the nearest 10%, the average distance from street to house, and the average distance between houses. I averaged these parameters over groups of 10 stops. I used a principal component analysis (Morrison 1967) to examine the relationships among the habitat factors. Principal component analysis derives the linear relationship among the habitat variables that best explains their variance between locations.

Using 10-stop units I determined the average number of species per stop and the average bird density per stop. The index of within-habitat diversity was the average number of species per stop, and the total number of species in 10 stops was used as an index of total diversity. Between-habitat diversity is the ratio of total species to the average number of species per stop, and it reflects the turnover of species from stop to stop. Because neighborhoods in the inner city have more noise and birds are visible for shorter distances due to building density, the average bird density per stop cannot accurately be compared between city and suburban neighborhoods.

To classify bird species by density, I used the following definitions: (1) "abundant" for species with more than 10 birds per 10 stops in over 80% of 10-stop units, (2) "common" for species with more than 10 birds per 10 stops in some 10-stop units, (3) "uncommon" for less than 10 birds per 10 stops, and (4) "rare" for species that were not significantly different from zero by a t-test. I classified bird species by spatial distribution using (1) "wide-spread" for species found in more than 80% of 10-stop units, (2) "regular" for species found in 20% to 80% of 10-stop units, and (3) "irregular" for species found at fewer than 20% of 10-stop units. Several species that were uncommon in some years but absent in

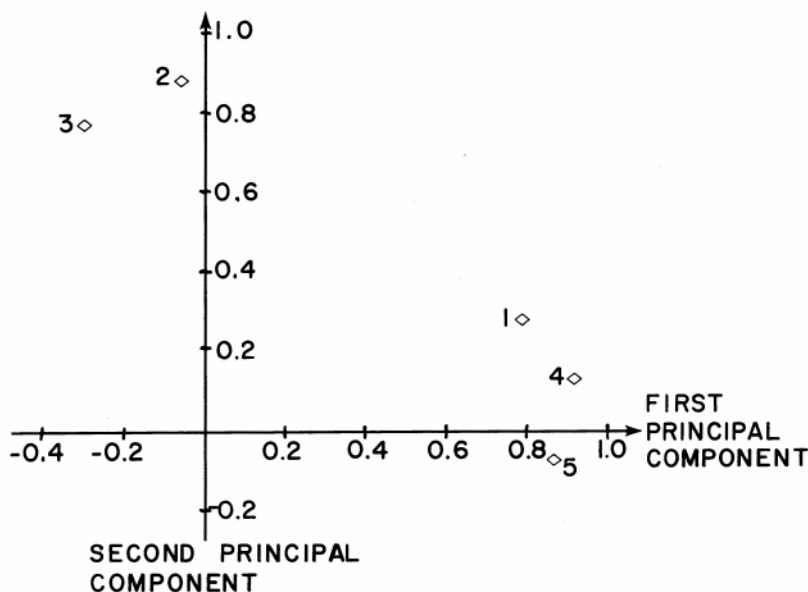


Figure 2. Plot of 5 habitat variables on their principal components. The relative position of each variable on the principal component axes is indicated, and the 2-dimensional structure of the habitat is illustrated. The habitat variables are (1) percent of tree canopy (2) percent of lots used for residential purposes (3) percent of lots occupied by buildings (4) average distance from street to house (5) average distance between houses.

others did not fit the above classifications, and were termed "periodic." Common names of birds follow American Ornithologists' Union (1967) and supplements.

The Chicago metropolitan area in northeastern Illinois extends along the western shore of Lake Michigan from Wisconsin to Indiana and includes a human population of 7 million people (U. S. Bureau of the Census, 1977). This area includes the Chicago plain and Valparaiso moraine that were occupied by upland forests, prairies, lakes, swamps, and sand dunes, but urban development has now obscured these features (Schmid 1975). The habitat-along routes surveyed is now overwhelmingly residential (80%), with a few open fields, industrial sites, and commercial properties present. Residential areas along the survey routes varied from wooded neighborhoods with large yards to densely populated areas with almost no space between buildings.

#### RESULTS

A principal component analysis of the habitat parameters suggested that the habitat structure was two-dimensional because the

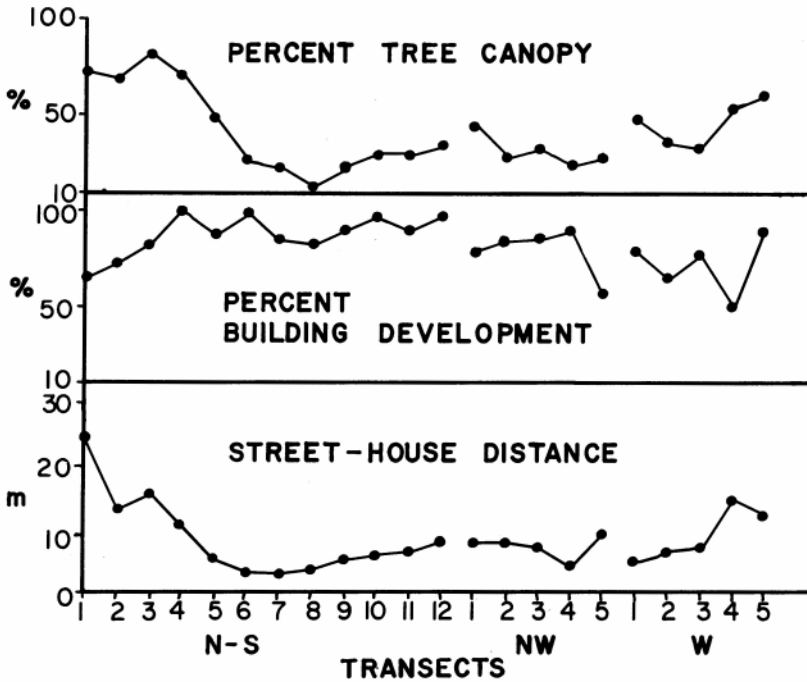


Figure 3. The percent of tree canopy, percent of lots occupied by buildings, and the average distance from street to house (in meters) are presented for North-South, Northwest, and West transects of the Chicago metropolitan area.

first two components explained 76% of the variance among stops. The extent of tree canopy and larger yard length and width determined the principal component of the habitat. The extent of building development at a stop and the degree of residential development, as opposed to commercial or industrial, determined the second orthogonal component (Figure 2). Densely populated areas with small yards produced low values of the principal component. The northern suburbs were largely forested (over 65% tree canopy) with large yards. The city of Chicago proper had close buildings with significantly smaller distances between houses and from street to house ( $p < .01$ ,  $t$ -test). The southern and western suburbs did not have as much area in wooded, large yards as the northern suburbs (Figure 3).

There were 51 breeding species observed on the 5 routes over 3 years. The average number of species per stop, the total number of species per 10-stop unit, and the average bird density per stop with its standard deviation are reported in Table 1 for 1976. The average number of species per stop ranged from more than 8 in the northern, forested suburbs to as few as 3.4 in Chicago inner-city

**Table 1.** Average and total numbers of species seen and bird density for ten-stop units of transects in 1976.

Location	Mean species per stop	Total species in ten stops	Mean density per stop	Standard deviation of density
<b>Lake County route and northern route</b>				
1	8.5	27	19.9	8.2
2	8.9	29	25.7	6.5
3	9.1	27	21.7	7.1
4	7.7	21	30.4	13.4
5	4.9	11	23.3	8.6
6	3.8	8	16.4	8.0
7	4.0	9	18.0	7.2
<b>Southern route</b>				
1	3.4	13	14.5	10.7
2	5.0	13	20.9	7.1
3	6.3	17	21.4	4.1
4	5.3	14	18.1	6.4
5	5.5	11	21.5	8.5
<b>Northwest route</b>				
1	5.6	16	20.3	11.3
2	8.0	23	35.7	9.9
3	5.0	12	20.8	8.1
4	3.8	10	14.1	4.6
5	4.7	13	20.6	16.1
<b>Western route</b>				
1	5.4	17	17.6	10.1
2	5.8	12	27.0	7.7
3	6.7	21	59.0	82.6
4	7.6	29	27.9	6.3
5	6.1	15	25.6	6.0

neighborhoods. The total number of species per 10-stop unit varied from 29 species in the northern and western suburbs to as few as 8 in central Chicago. Average bird density varied from 59 birds per stop to 14 per stop for 10-stop units. The average number of species per stop and total species per ten stops significantly correlated ( $p < .01$ ) with the extent of tree canopy and the width and length of yards (principal component of habitat). Total species per ten stops and between-habitat diversity were significantly negatively correlated ( $p < .01$ ) with the percentage of residential habitat and building development at the stops (second principal component). Total bird density was not correlated with habitat features.

The number of bird species observed varied significantly between different routes ( $p < .01$ ), but within routes there was little variation between years (Table 2). In contrast, average bird den-

Table 2. Annual changes in Breeding Bird Survey results.

Location		Mean species per stop	Total species in ten stops	Mean density per stop
Lake County route	1976	8.8	37	22.4
	1977	8.5	35	23.7
	1978	8.1	32	20.7
Northern route	1976	5.1	26	22.0
	1977	4.7	23	22.3
	1978	5.1	22	23.0
Northwestern route	1976	5.4	29	22.3
	1977	5.4	29	24.4
	1978	5.2	27	18.2

sity showed more variation between years than between routes. Variation in bird density was greatest in the northwestern route. Despite annual changes in absolute abundance as great as 33%, the relative abundances of different species of birds in a neighborhood were stable. The more abundant species of a neighborhood remained dominant year after year. For example, in Highland Park, the two most abundant species were House Sparrow and Starling, followed by Common Grackle, then Chimney Swift in each of three years. The total density of these four species was 67-70% of the total bird community each year. In the near west side of Chicago, the most abundant species was the House Sparrow, followed by the Rock Dove and Starling, totalling 89-92% of the bird community in each of three years. In Des Plaines, the most abundant species was the House Sparrow, with the American Robin, Starling, and Common Grackle next, and the Blue Jay fifth in two years out of three, totalling 79-86% of the total bird community each year. These trends in relative abundance held despite annual changes in bird density.

Bird population preferences for particular routes remained stable. The locations of greatest abundance for a species were frequently the same each year, and the Spearman rank-correlation for 12 10-stop units between 1976 and 1977 was statistically significant ( $p < .05$ ) for each of the most abundant 10 species in Table 3. Average bird densities per stop for the 20 most abundant species

Table 3. Densities of selected birds for 10-stop units of the Chicago area, 1976-1978. P indicates low density presence. Neighborhood names are approximate locations of 10-stop units.

Species	Lake Forest	Wilmette	Central Chicago	Blue Island	Home-wood	Des Plaines	Chicago (Rogers Park)	Oak Park	Lombard
Total density per stop	19.9	28.8	21.5	21.4	21.5	22.6	17.2	17.6	27.9
House Sparrow	1.7	11.3	10.4	7.2	5.6	7.8	9.8	6.0	5.8
Starling	1.9	5.4	3.8	5.1	7.4	2.8	2.5	2.7	5.5
Common Grackle	4.2	3.7	0.4	3.8	3.9	3.5	0.3	1.5	6.1
American Robin	2.9	1.9	0.8	2.0	2.4	3.6	0.5	3.4	2.3
Rock Dove	0.1	1.4	6.3	0.8	-0-	0.2	1.8	0.2	0.3
Chimney Swift	0.9	1.0	0.5	0.4	0.7	0.2	1.8	0.1	0.3
Blue Jay	1.3	1.4	-0-	0.4	0.1	1.0	0.1	0.8	0.7
Red-winged Blackbird	0.6	-0-	0.1	-0-	-0-	0.1	0.2	-0-	2.8
Cardinal	0.9	0.5	-0-	0.5	0.4	0.7	P	0.6	0.3
Common Crow	1.3	0.2	-0-	0.2	-0-	0.8	-0-	0.4	0.3
Mourning Dove	0.6	0.2	P	0.3	0.4	P	-0-	0.1	0.1
Common Nighthawk	0.1	0.1	P	P	-0-	-0-	P	0.8	-0-
House Wren	0.5	0.2	-0-	-0-	0.4	0.1	-0-	-0-	0.1
Downy Woodpecker	0.3	0.2	-0-	0.1	-0-	0.1	-0-	0.1	0.4
Blk-cap Chickadee	0.5	0.2	-0-	-0-	-0-	0.2	-0-	-0-	0.2
Brown-headed Cowbird	0.1	0.1	-0-	-0-	0.1	0.1	-0-	-0-	0.3
Song Sparrow	-0-	-0-	-0-	0.1	0.1	0.2	-0-	-0-	0.3
Common Flicker	0.1	P	P	0.1	-0-	P	-0-	0.2	0.1
Chipping Sparrow	P	-0-	P	-0-	-0-	0.1	-0-	-0-	0.3
Purple Martin	0.3	-0-	P	-0-	-0-	-0-	0.1	-0-	-0-

are given in Table 3. Mourning Dove, Blue Jay, Common Crow, Black-capped Chickadee, Red-eyed Vireo, Common Grackle, and Cardinal densities were significantly correlated ( $p < .05$ ) with the extent of tree cover and length and width of lawns (principal component). Blue Jay, Black-capped Chickadee, and Red-eyed Vireo were most common in forested suburbs and seldom were



Table 4. Density and distribution patterns of urban bird species.

Density	Distribution	Species
ABUNDANT	WIDESPREAD:	American Robin, Starling, House Sparrow
	REGULAR:	None
	IRREGULAR:	None
COMMON	WIDESPREAD:	Rock Dove, Chimney Swift, Common Grackle, Cardinal
	REGULAR:	Blue Jay, Common Crow, Red-winged Blackbird
	IRREGULAR:	None
UNCOMMON	WIDESPREAD:	Mourning Dove
	REGULAR:	Common Nighthawk, Common Flicker, Downy Woodpecker, Purple Martin, Black-capped Chickadee, House Wren, Brown-headed Cowbird, Chipping Sparrow, Song Sparrow
	IRREGULAR:	Mallard, Killdeer, Red-headed Woodpecker, Eastern Kingbird, Great Crested Flycatcher, Eastern Wood Pewee, Barn Swallow, Gray Catbird, Wood Thrush, Red-eyed Vireo, Common Yellowthroat, Rose-breasted Grosbeak

elsewhere, but Common Grackle and Cardinal were widespread. House Sparrow and Rock Dove were significantly negatively correlated with the above variables ( $p < .05$ ), and they dominate the north central Chicago residential area. American Robin and Chimney Swift were uncorrelated with the first principal component of habitat. Starling, Red-winged Blackbird, and Chipping Sparrow were significantly negatively correlated with percentage of residential habitat ( $p < .05$ ). Chipping Sparrows were more common in suburbs with large shrubs and yards, but few large trees. Red-winged Blackbirds were found in open fields between developments, although a few birds were in residential neighborhoods. Because of the varied habitat preferences of different species, total average bird density was uncorrelated with habitat structure.

Birds could be classified into 6 patterns based on abundance and distribution, with two remaining patterns that were unclear in

abundance and distribution (Table 4). American Robin, Starling, and House Sparrow were present at more than 2/3 of all stops on routes censused. House Sparrows reached peak densities in dense Chicago residential habitat, whereas American Robins and Starlings were more abundant in the suburbs. Rock Dove was most common in Chicago proper and at locations such as bridges and schools, but the other common, widespread species peaked in suburban sites.

Uncommon bird species preferred particular habitats or locations. Common Nighthawks were found in neighborhoods with gravel roofs. Downy Woodpecker had a significant population increase in 1977 in the northern suburbs ( $p < .05$ ). Purple Martin and Black-capped Chickadee also increased in the northern suburbs after 1976. The Great Crested Flycatcher, Eastern Wood Pewee, Wood Thrush, and Rose-breasted Grosbeak were most common in the northern suburbs. Eastern Wood Pewee significantly declined in 1977 ( $p < .05$ ,  $t$ -test). House Wren and Brown-headed Cowbird were found in all suburbs, but Chipping Sparrow was absent from the southern suburbs, and Song Sparrow from the northern suburbs.

Five bird species fluctuated in abundance from year to year and could not easily be ordered into patterns of abundance or distribution. These periodic species were absent in at least one year after being significantly present ( $t$ -test,  $p < .05$ ), and included Yellow-billed Cuckoo, Northern Oriole, Scarlet Tanager, Indigo Bunting, and American Goldfinch. Yellow-billed Cuckoo, Northern Oriole, and Indigo Bunting were significantly present in 1976, absent in 1977, but recovered in 1978. These shifts may be part of region-wide trends in northeastern Illinois.

Rare species were those found in at least one year at very low densities such that sampling error between years is likely. Rare species included Green Heron, Ring-necked Pheasant, Belted Kingfisher, Hairy Woodpecker, White-breasted Nuthatch, Long-billed Marsh Wren, Brown Thrasher, Rough-winged Swallow, Cedar Waxwing, Bobolink, Eastern Meadowlark, Warbling Vireo, Rufus-sided Towhee, and Field Sparrow. White-breasted Nuthatch significantly increased in 1977, but decreased in 1978.

#### DISCUSSION

The number of species, bird density, and identity of species appears quite uniform across the Chicago metropolitan area. There are few pockets of unusual species in residential areas. There are fewer bird species in the central city and more species in the suburbs. The northern suburbs with wooded residential areas have several species not found elsewhere. Because Rock Doves are larger, the greatest bird biomass is found in the inner city, but I was unable to determine any major shifts in bird density between routes by the BBS technique.

The abundant species of this urban area seem to have little selectivity for particular neighborhoods. Greater abundance in a species may obscure habitat preferences because the birds overflow into unfavorable habitat (Fretwell 1972). Those less common species that are typically found in forest are more limited to wooded suburbs and forest edge. The abundance of forest and forest edge birds in wooded suburbs in this study agrees with Williamson (1972) in Washington, D. C., where House Sparrow, Starling, and Rock Dove dominated apartment building neighborhoods, but "forest" species were found in affluent suburbs.

Habitat differences between urban neighborhoods affect both the number of species and the composition of species present. Habitat differences determine the presence or absence of a particular species and its relative abundance at each location. Despite annual fluctuation and little difference between locations in total bird density, differences in habitat critically determine the bird community in residential neighborhoods. Habitat parameters should be recorded in studies of bird populations in residential neighborhoods as well as in many Breeding Bird Surveys (Weber and Theberge 1977).

The presence of different patterns of bird abundance and distribution similar to the incidence functions of Diamond (1975) is striking. In several archipelagoes of Pacific islands, Diamond (1975) noted that the presence or absence of a species on an island could be predicted from an incidence function that characterized the species' distributional strategy on islands with varying numbers of species. The birds dominant in residential areas were selected from abundant and common, widespread species, similar to tramps of Diamond (1975). Periodic and irregular species are more restricted to forest or wooded suburbs, similar to the high-S species described by Diamond (1975). Of the 51 species observed in this study, only 5 species comprise 85% of the bird community. These species were House Sparrow, Starling, Common Grackle, American Robin, and Rock Dove. The first four species are the most abundant birds not only of this study, but also on farmsteads of rural Illinois (Guth 1976). Although farm and city seem to be contrasting habitat, a closer look reveals that farmsteads and residential neighborhoods both have buildings, grassy yards, scattered trees, and shrubs. The same bird species, those of the widespread and abundant or common patterns, dominate in this habitat. All species other than the most abundant five species are 1 or 2 orders of magnitude less abundant than House Sparrows in the Chicago metropolitan area.

These patterns of bird abundance and distribution, the significance of habitat in determining bird community composition, and the extensive similar bird community throughout much of the Chicago metropolitan area and rural Illinois farmsteads, all point to the extensive impact of urbanization on the bird community.

The structure of these urban neighborhoods strongly controls the bird composition. The disturbed habitat favors particular species and patterns of species. Changes do occur in this community (Rand 1956, Johnson and Cowan 1974) as important species such as House Sparrows or Starlings invade or decline. Because of the role of the habitat effects of urbanization, and of historical changes in the bird community on the continent, the common bird species of metropolitan areas such as Chicago bear further monitoring over the years.

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